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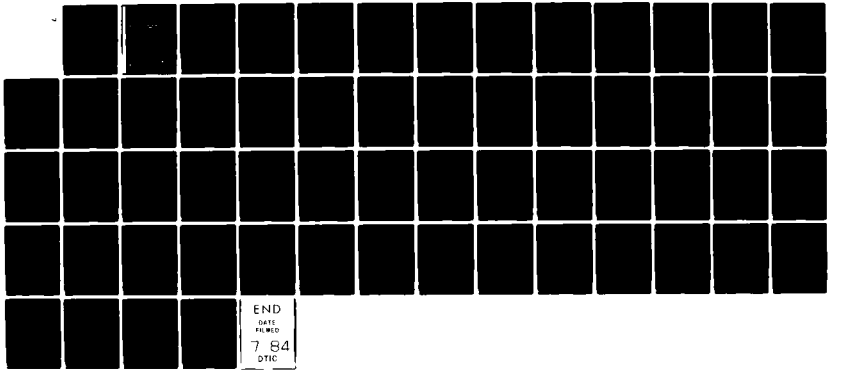

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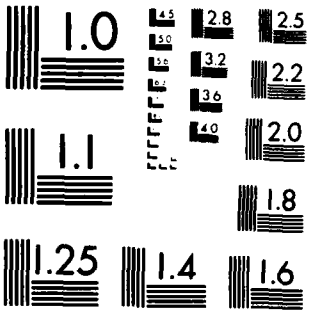

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MODIFICATION OF CURRENT FEEDBACK STRATEGIES: A TEXT SYNTHESIS APPROACH

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In the feedback condition subjects were given five tokens to determine if a card had been appropriately placed. The no-feedback students did not receive any assistance in determining the correctness of placement. In both conditions subjects signalled when they thought they were through.

The dependent measures were time (in minutes), number of moves, concordance with the author's original order of sentences, percentage recall (the number of idea units recalled), and percentage recognition (choosing the original sentence from a pair containing a paraphrase). The recall and recognition measures were given directly after completion of the task. The independent variables were feedback/no-feedback, content, and number of sentences.

MANOVA and MANCOVA analyses suggested that content and number of sentences exerted a greater influence on processing and subsequent recall and recognition than did the presence or absence of feedback. Concordance with the original order of sentences was not critical in determining subsequent recall or recognition. Protocol analyses confirmed this finding regarding concordance.

With content and passage length as random rather than fixed-effects, the statistical significance of these findings suggest that much of the previous feedback literature may have been experimentally confounded. In addition, the text synthesis approach more clearly demonstrates the idiosyncratic nature of cognitive processing and the difficulty of providing valid feedback for the individual student. It was proposed that the text synthesis approach be used to direct feedback towards a free choice/menu model. Further extensive experimental work along these lines is needed.

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Modification of Current Feedback Strategies:

A Text Synthesis Approach

Abstract

Two passages, each consisting of a 13 and 19 sentence version, were constructed from the same essay on the development of the atom bomb. The passage sentences were individually typed on index cards, and the four resulting packets were then scrambled. Subjects were undergraduate psychology students at the University of Colorado who received one of the four scrambled orders of sentences. Subjects serially reconstructed the passages using a slotted board.

In the feedback condition subjects were given five tokens to determine if a card had been appropriately placed. The no-feedback students did not receive any assistance in determining the correctness of placement. In both conditions subjects signalled when they thought they were through.

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With content and passage length as random rather than fixed-effects, the statistical significance of these findings suggest that much of the previous feedback literature may have been experimentally confounded. In addition, the text synthesis approach more clearly demonstrates the idiosyncratic nature of

cognitive processing and the difficulty of providing valid feedback for the individual student. It was proposed that the text synthesis approach be used to direct feedback towards a free choice/menu model. Further extensive experimental work along these lines is needed.

Modification of Current Feedback Strategies: A Text Synthesis Approach

Educational specialists are currently under pressure to demonstrate an increased response to demands for individualized instruction. The stress on individualization reflects increased emphasis on mastery learning (Bloom, 1981), increasing utilization of cost-effective technology, and special needs of students (Gage & Berliner, 1979). Such learning approaches are generally defined as systems in which the learning environment is organized and maintained from feedback derived uniquely from each individual student (Langer, 1978). Feedback, in turn, is generally defined as anything that tells the student if the answer is right or wrong.

Typically feedback is an adjunct process designed to adjudicate differences between the intent of the instructional program and perceived outcomes of student interaction. Almost invariably, feedback is assumed to follow a response. Moreover, most systems assume a direct and predictable effect of the feedback provided.

However, the assumption of direct causality between an instructional stimulus (e.g., content, feedback) and subsequent cognitive processing is generally unproven (Winne, 1982; Bilodeau, 1969). Validation of any process based upon a product (i.e., a response) is difficult, since one has to prove there was no other way the student could have derived the response (e.g., alternative strategies). Indeed, for the behaviorists the assumption of a conditioning paradigm with deterministic transformations (e.g., generalization and discrimination gradients) is absolutely critical. However, no systematic body of information exists on feedback for the instructional developer.

Feedback is a difficult construct to validate, primarily because a number of theoretical positions are embedded in the concept. One is the incentive-information controversy. Since the instructional implications of feedback may be considered originating essentially from the work of Thorndike

(Thorndike, 1932), behaviorists have defined it as the consequences of a given response and made it operationally part of the conditioning paradigm (Anderson & Faust, 1973). Thus, one could speak of reward and punishment as confirming and disconfirming consequences respectively, and feedback overall in terms of an incentive model (Buss, Braden, Orgel, & Buss, 1956). The feedback term "knowledge of results" (KR) can also easily be utilized by behaviorists, if the confirmation/disconfirmation produces concomitant changes in probability of response through conditioning. Instructionally, more informative KR models can be maintained within the conditioning paradigm (Anderson, Kulhavy, & Andre, 1971), since the behavioral position does not deal directly with the input of information on incentive, per se. Feedback under these circumstances becomes a mechanistic process of confirming-disconfirming, modifying thought by strengthening or suppressing associations. The cognitive position, on the other hand (e.g., Atkinson & Wickens, 1971), assumes that the information provided contributes directly to the immediacy and direction of change. The cognitive viewpoint accepts idiosyncratic transformation of data.

Unfortunately for the strictly behavioral position, the phenomenon of subjective organization including the use of strategies in recall is well established (e.g., Anderson, 1980). Indeed, as early as 1932 Bartlett postulated the principle of constructive memory. Other types of memory organizations have been subsequently derived in addition to subjective; i.e., categorical and associative organization are well established constructs.

The meaningfulness of the material appears to influence recall, although the findings have not established a clear pattern (e.g., Glidden & Roemer, 1974; Gorfein & Blair, 1971). However, while subjective organization may vary from individual to individual, there is stability within the individual. Thus Kozminsky, Kintsch, Coreu, & Bourne (1979) found at least four different strategies in a moderately complex decision-making problem, while Sternberg and

Ketron (1982) found that untrained subjects in an analogy problem solving task tended to utilize reliably effective self-generated strategies. These individual differences lead to problems involving linear feedback models, since the developer's assumptions about what is needed may differ markedly from those of the learner at any point.

The thesis can be made that recent advances in cognitive science have invalidated many earlier behavioral assumptions about learning. To the curriculum developer, particularly in learning situations depending on a heavy feedback component, the issues have grown exceedingly more complex. Behavioral management systems have followed Skinner's dictum of small controlled steps to reduce error, and as a consequence feedback has been dictated by the assumption that the strategy minimizes significant individual transformations of meaning.

The paradox is that while modern cognitive theory can be described accurately as information-processing (Bourne, Dominowski, & Loftus, 1979), the cognitive theorists have not resolved problems of content and sequencing, especially in higher-order learning environments. The issue of feedback is scarcely addressed in instructional terms (Clark, 1982). Behavioral approaches have had a great deal to say about content and sequencing as well as feedback, but have generally ignored learner transformations. The cognitive position sees the informational dimension of feedback as directive, and regards the incentive dimension as minimal in most cases.

The cognitive question therefore is basically: what kinds of information? In a recent study prespecified schemata were matched to the organization of the content, and student learning was enhanced (Brooks & Dansereau, 1983). Typically though, classroom instructional environments do not operate under such precise controls. Thus, the feedback may assist, hinder, or have no impact at all.

However, recognizing the necessity of immediate change in case of error,

the behavioral psychologists have developed the concept of "corrective" feedback, defined as specifically directing the learner to modify an incorrect response (Anderson & Faust, 1973). Whereas knowledge of results (KR) assumes that probability of response will eventually change through conditioning, corrective feedback mandates changes.

The incentive-informational dispute is probably the most central issue, and has not been resolved. Indeed, it is likely that feedback combines both aspects, although the experimenter has the opportunity to suppress or enhance either dimension depending on design bias (Getsie, 1982).

Another major problem in neatly conceptualizing feedback is that it is basically a multi-dimensional concept (Holding, 1965). Using a branching paradigm, Holding postulated several dichotomies. The first creates a distinction between extrinsic and intrinsic feedback. Each of the first pair, in turn, can be subdivided into concurrent and terminal. Subsequent dichotomies include: immediate-delayed, verbal-non-verbal, and separate (after each response)-accumulated (after all responses). The number of possible permutations and combinations is awesome. A perusal of the dichotomies clearly indicates that feedback experiments are likely to persist in having the directive and incentive results confounded (Locke, Cartledge, & Kleppel, 1968), although as previously suggested by appropriate selection of treatment variables the incentive or information component can be suppressed.

Feedback, regardless of conceptual complexities and mixed research findings (e.g., Barringer & Gholson, 1979), is considered a critical component by most instructional systems analysts and psychologists (e.g., Davis, Alexander, & Yelon, 1974). By any set of standards it is considered absolutely essential in designing auto-tutorial systems involving computer-based instruction (e.g., Gagne, Wager, & Rojas, 1981). The reason is that under conditions of individualized instruction the student is severely limited in terms of different

sources of feedback, and hence the "equalization phenomenon" (Hilgard & Bower, 1975) is attenuated. That is, the student cannot make up for deficiencies anywhere in the instructional situation by utilizing a variety of informational sources. We are not arguing that teachers in traditional classrooms are better managers of feedback. Rather, in individualized technologically-assisted settings the student is obviously more restricted in terms of possible sources of assistance.

Behavioral psychologists, as well as those interested in the area of artificial intelligence (AI) have not been unmindful of this problem (Bunderson & Faust, 1976). Given the early failures in machine language, more extensive attempts were made to develop sophisticated programs which were capable of carrying out a tutorial dialogue with the student. One example was SOPHIE (Sophisticated Instructional Environment), built around problem-solving electronic circuitry (Brown, Burton, & Bell, 1974).

The basic assumption was that by providing detailed and analytical feedback, errors could be markedly reduced, and students redirected in their thinking (Brown et al., 1974). While students may attempt to correct themselves with repeated opportunities (e.g., Singer & Pease, 1978), most instructional psychologists point to findings of error perseveration (e.g., Kaess & Zeaman, 1960) as something to be avoided (e.g., Howe, 1970; Ladas, 1980). Ultimately, one supposes the goal is errorless learning (Terrace, 1963).

Unfortunately, recent work on tutorial languages suggests that the elaborated conceptual model may be detrimental to student performance (Gallagher, 1981). Using the BLOCKS program Gallagher provided diagnostic feedback and information based on an "expert" problem-solving model (which is typical of tutorial programs). However, students not given this help actually performed better on subsequent problems. Kulhavy (1977) has suggested that actually the more complicated feedback programs may be a form of learning task

in addition to the text. Certainly more is not always necessarily better.

Sternberg and Ketron's (1982) previously cited work also suggests that a predetermined feedback strategy model may actually be providing the learner with irrelevant data not compatible with the functional, student-generated strategy. It is ironic to note, when early assumptions about simplicity and directness of feedback in programmed instruction were invalidated by students short-circuiting the feedback process by copying answers (e.g., Anderson et al., 1971), subsequent attempts to overcompensate in the other direction may also have had deleterious effects. The key lies, of course, in the basic assumptions of a feedback model based on an "expert" or linear strategy versus those derived explicitly from an analysis of the individual learner's strategy. The difference is expressed also in terms of the curriculum model, with the curriculum developer on one hand deciding in advance what <u>should be</u> done as compared to a more functional analysis of what the individual learner <u>is</u> doing. While the research evidence supporting either experimenter or learner determined sequences is mixed (Dansereau, Evans, Wright, Long, & Atkinson, 1973), there is no reason for solely accepting the developer determined model.

There are a number of other issues worth noting. Foremost is the finding that disconfirmation (negative) feedback impacts achievement much more than confirmation (positive) feedback (Kulhavy, 1977). Researchers in concept acquisition (e.g., Bruner, Goodnow, & Austin, 1956; Trabasso & Bower, 1968) have found that learners shift strategy after disconfirmation, although not back to some simple random selection (Levine, 1966). Generally, the more subtle and/or qualitative aspects of feedback have been ignored (Kulhavy, 1977).

The use of feedback during and after the acquisition phase presents several problems. If it is given too soon or is too readily accessible, the error rate increases (Sullivan, Schutz, & Baker, 1967). Indeed, several researchers have allowed the subject to determine when feedback is to be given (Anderson et al.,

1971; Melching, 1966). The findings show no clear-cut superiority, but suffer from some methodological analysis problems which will be discussed later.

Moreover, delay in knowledge of results also has diverse effects. Kulhavy (1977) has argued that while feedback should be provided as often as possible during instruction, the content organization and difficulty of the material is also crucial. If the material is very difficult, students spend most of their time guessing at answers and trying to match feedback to the question (Kulhavy, Yekovich, & Dyer, 1976). However, where the material is relatively easy and/or student confidence is high, students spend relatively little time on feedback. Indeed, Kulhavy (1984) currently is concentrating on the confidence issue. Battig (1966), however, suggested that difficulty in learning might have positive consequences. Certainly the issues of when and how much feedback are significant in problems of transfer.

Moreover, delay in feedback seems to sometimes facilitate acquisition (e.g., Surber & Anderson, 1975). The argument is that the delay allows for incorrect responses to be forgotten, which approximates the practice interference paradigm (Kulhavy & Anderson, 1972). Finally, very pertinent to our theoretical position and use of feedback is a study by Kulhavy and Parsons (1972) which suggests that the effect of feedback is minimal unless the instructional content is organized in some way meaningful to the learner (e.g., schemata, script, etc.).

The notion of text organization appears to be critical. Researchers investigating the processing of prose have assumed that the key problem for the reader is to enhance meaningfulness, i.e., coding. The text analysis approach has developed within a number of specialized subareas, including grammar, content, orienting tasks, and knowledge bundles. At the present moment, the theoretical trend is epistemological (i.e., how knowledge is structured). Current theories have been tied essentially to measures of recall (Reder, 1980).

Research has clearly demonstrated that recall for prose is subject to the logic of the discourse (e.g., Frase, 1969; Kulhavy, Schmid & Walker, 1977), as well as the serial position of the discourse elements. There have been a number of attempts to characterize text processing (e.g., Dawes, 1964; Crothers, 1972; Fredericksen, 1975; Rumelhart, 1977; Meyer, 1975). Most have been characterized as more or less successful within the limits imposed by the specific model (Reder, 1980). Generally these programs attempted to simulate via computer the sequential reorganization of prose during processing. Sequence of proposition occurrence is an explicit parameter in one of the most important theories of text processing (Kintsch & van Dijk, 1978).

More recently, attempts have been made to link acquisition to outcomes of schemata (or related constructs). These are usually defined as abstract representations of knowledge within the memory structure of the learner (e.g., Rumelhart & Ortony, 1977), and are considered an integral part of text processing. The Brooks and Dansereau (1984) study is a typical example of this approach. It is assumed that input can be facilitative or interfering depending on the interaction between schemata and discourse logic.

Subjective organization, as analyzed in text processing, is also a function of familiarity and meaningfulness. Indeed some researchers (e.g., Anderson & Reder, 1979) argue that the schemata available to the subject may have more impact on acquisition than the logic of the discourse itself.

While considerable progress has been made using well formed texts, comparatively little systematic research has been done using disconnected discourse. This is surprising since the lack of apparent content organization would tend to equalize subjects initially regardless of prior experiences with the materials. One would assume under these circumstances the impact of feedback should be maximized, since subjects should need help to develop the logic of the passage. In most feedback studies, the procedure has been to

develop the discourse logic so tightly, that individual differences in processing are minimized. This may be confounding the feedback problem. Generally, the findings with disconnected discourse lack coherence in terms of outcomes. Overall, using a free recall procedure, scrambled sequences generally yield poorer performance than connected discourse, regardless of unit size (Dansereau et al., 1973).

In many experiments involving scrambled presentation little is done to assist the learner using disconnected materials. In a typical study (Frase, 1969), subjects using a name concept strategy were superior to those using an attribute strategy, and both were superior to the scrambled order group. Sasson (1971) interrelated two different topics, a variant of the scrambled order method, and found in both instances that a thematic organization produced superior student achievement as compared to temporal (i.e., sentences included a date) and logical arrangements.

Meaningfulness of the materials has also been investigated. Bruning (1970) embedded the test items in contexts which were relevant and ordered, relevant and scrambled, and irrelevant and scrambled. The findings are somewhat unusual in that there was no significant difference between the relevant and ordered and the relevant and scrambled contexts, but both were superior to the irrelevant and scrambled. As in nearly all these studies the discussion dealt with concept acquisitions in the ordered material; no one seemed to pay much attention to the what and how of achievement in the scrambled treatment. Tobias (1973) using programmed instruction, found that familiarity overcame to some extent the effects of scrambling. Again using programmed instruction, Brown (1970) found that students encountering a scrambled mathematics sequence took more time, made more errors, and performed more poorly on problems. This is to be expected in a subject area in which meaning is clearly tied to a hierarchical sequence.

The interrelatedness of the sentences is also a factor. Kissler and Lloyd

(1973) found that highly interrelated sentences were more sensitive to scrambling, and argument overlap is an important part of the Kintsch and vanDijk (1978) definition of macroproposition. Rothkopf (1962) indirectly assessed this dimension when he used loosely organized sentences to create his discourse treatments. Anderson (1966) suggested that programmed instructional units (i.e., the frames) are developed to be independent, and with the high redundancy of programmed instruction units scrambling may not be as destructive of performance. In a more recent study, Taylor and Samuels (1983) found that children who were aware of text organization recalled more of normal passages than scrambled, but children who were unaware of organization showed no differences between normal and scrambled passages. Unfortunately, as in many of these studies, the text was artificially structured. One wonders if the contrived logic did not interfere with the strategies usually employed by some children.

While none of the studies cited a feedback mechanism, a study done by Schultz and DiVesta (1972) is unique in that students were allowed to take notes (an outside confirmation source). Again, while the emphasis was on the strategies employed with respect to organized materials, the researchers also observed that students taking notes modified the passages to suit their needs. That is, they were not forced to at least initially accept the experimenter-determined logic.

In summary, Bartlett (1932) demonstrated that strong recall tended to fit schemata. Current research (e.g., Kintsch & vanDijk 1978; Meyer, 1975) has reaffirmed this proposition by demonstrating that the probability of inclusion within recall is related to the importance of the statement to the theme. Instructionally, the implications are significant, in that organization appears to be modified at time of input (Mandler, 1972). Hence, relevancy is a function of learner schemata. Behaviorally oriented instructional psychologists can

develop algorithms for organizing concept elements (e.g., Merrill & Tennyson, 1979) only by ignoring the mechanism of chunking (Miller, 1956; Buschke, 1976). Since it is assumed that feedback involves active memory (Anderson, 1980), both timing as well as congruence of feedback to schemata and strategy are crucial.

It can be argued that in most educational situations, particularly in higher-order and non-hierarchical learning, feedback might better serve by assisting in self-correction (Anderson, 1980). This avoids the problem of the instructional developer intruding into functional and perhaps unique memory and processing strategies. Certainly we should take heed from Nisbett and Wilson's (1977) findings that learners often cannot accurately verbalize their own strategies. If they cannot do it, then instructional psychologists may indeed be on dangerous conceptual grounds. Hence, while Singer (1980) called for optimizing feedback, in the end it may be the learner that dictates the meaning of "optimal." This research begins to address such issues.

Procedures

The subjects were 64 Fall '83 undergraduate students from the Introductory Psychology course at the University of Colorado. All students in the course are required to spend several hours as subjects in psychological experiments as part of the course requirements. The subjects were given the task on an individual basis, with order of treatments randomly assigned.

The passages selected were broken down and ordered by sentence. Within the passage each sentence was typed separately on a 3x5 index card. To assist subjects in ordering the sentences, a wooden board with 35 slots was constructed. Each slot provided space for one card. Cards had to be picked up one at a time, and placed in the slots. This forced serial processing.

The subjects were informed that the purpose of the experiment was to determine how people made meaning from material they read, particularly how meaning is constructed. To familiarize the subjects with the experimental task,

they first performed a practice task which consisted of ordering 11 sentences comprising the story of "The Goose that Laid the Golden Egg." As in the experiment, each card contained a single sentence, with the order of cards scrambled. The subjects were told to reorder the sentences to make the best complete story, and signal when they felt the story was complete. All questions regarding procedures were answered at this time.

If the subject was to receive the feedback treatment on the experimental passage to follow, the experimenter gave the subject five tokens to be used for feedback during the practice task. The experimenter informed the subject that by giving up a token, the subject would be told if a card had been placed correctly. Thus, they could ask for help a maximum of five times if they needed it. The subject was told that a "yes" meant that the card in question was correctly placed with respect to the card immediately preceeding it. Any other placement was considered a "no". For example, suppose the subject picked up card #7 in the preassigned order. If the card was placed directly after card #6, the move was designated as correct; any other placement was wrong. The no-feedback subjects were not given any assistance.

Following the practice task, the subjects were given one of four scrambled packets of cards. The passages were drawn from two sections of Laura Fermi's account of the development of the first atomic bomb (Gardner, 1957). Throughout our discussion, the passages will be referred to as A and B. Both passages were related to the development of the atomic bomb, although the phrase "atom bomb" never appears per se in the passages.

For each passage a 13 and a 19 sentence version was prepared. The sentences except for very minor modifications were verbatim, with the order following that of the text author. The 19 sentence passage included the 13 sentence version plus an additional six sentences from passages immediately following or preceding the smaller version. Hence, the four passages are

designated A-13, A-19, B-13, and B-19. For each passage, two randomized orders were used, although each subject used only one order. Subjects, therefore, received a scrambled packet of 13 or 19 cards, with one of two contents.

As indicated earlier, the subjects were assigned to either a feedback or no-feedback condition. The feedback subjects received five tokens once more, while the no-feedback subjects again reconstructed a passage without assistance. The subjects signalled when complete. Immediately after the cards had been ordered, the subjects were tested on recall and recognition in that order. For the free recall task, the subjects were asked to "write down as many sentences as possible; they need not be verbatim or in any special order." For the recognition task, the subjects were given a test consisting of 13 or 19 pairs of sentences (depending on which length they had been assigned); within each pair, one sentence was an original while the other was a paraphrase. The subjects were asked to choose the original sentence.

The independent variables were content (CO), number of sentences (NS), and feedback condition (FB). The dependent variables were time to order the passage (TM), number of moves (MV), number of tokens used (TK), concordance (TA), percent recall scores (RL), and percent recognition scores (RG).

Feedback as a confirmation-disconfirmation rationale has been explained. A "move" was construed as changing the relative position of a card to one or more other cards. For example, consider three cards in sequence: #1, #2, and #3. If Card #1 was placed between #2 and #3, or after #3, either change was counted as one move.

The starting and stopping times were recorded to give a measure of time, and the number of tokens used was also recorded. In addition, while the subjects took the recall and recognition tests, the experimenter recorded the sentence order in which the subject had placed the cards. Kendall's Tau was used to obtain a measure of concordance with the original text order. The

recall and recognition scores were derived from the written materials and paired sentences respectively.

Analysis

The experimental design was a factorial 2 (feedback - no feedback) x 2 (number of sentences: 13 - 19) x 2 (content: A - B). All cells were equally balanced as to number of subjects. To repeat, the dependent measures were % recall (RL), % recognition (RG), time (TM) in minutes, moves (MV), concordance (TA), and number of tokens (TK). The independent variables were feedback (FB), number of sentences (NS), and content (CO).

Prior to the scoring of the recall tests, the selections were broken down into idea units, following the work of Bovair and Kieras (1981). Table 1 gives the number of idea units for each passage.

Insert Table 1 about here

Although the passages were taken from the same short chapter by Fermi, if the number of idea units can be construed as a measure of cognitive complexity, the "A" material appeared to differ from "B". The significance of the difference was obviously an empirical issue. Both passages, however, followed the same narrative style of the author. In order to compare recall for the different numbers of ideas in the four passages, scores were converted to percentages, and are reported as such throughout.

The first analysis employed was MANOVA, using TM, MV, TA, %RL, and %RG as dependent measures. Table 2 presents the MANOVA data. All the appropriate F values reported are Hotellings' coefficients.

Insert Table 2 about here

Interestingly, there were no interaction effects. Table 3 presents the univariate Fs for the dependent variables, main effects only.

Insert Table 3 about here

The means and standard deviations for the dependent variables are given in Table 4.

Insert Table 4 about here

From the pattern of significant univariate F tests as a guide, several trends became clear. With feedback, the means for TM (13.2 minutes) and MV (12.3 minutes) differ significantly from the no-feedback condition (9.0 and 8.8 minutes, respectively). These results are to be expected, since subjects having feedback available would be expected to make more moves and use more time. The simple r between time and moves is .74, which is significant at the .01 level.

Within number of sentences, the 19 sentence passage means for TM and MV are higher than 13 sentence passage means (7.3 and 6.6 versus 15.2 and 14.4, respectively). Longer passages should require more processing time, and this is reflected in the data. As one might also expect, the mean for TA (concordance) is higher for the shorter passages as compared to the longer ones (.63 and .29 respectively). As the size of the passage increases, the likelihood that the subject will derive an order exactly like the original diminishes, regardless of feedback. It began to appear that passage length should be treated as a random variable, which has not been the customary procedure in the past. Finally, % RL was higher for the shorter passages (48.2 vs 39.3); although non-significant, % RG followed the same trend.

The main effect form for number of sentences (NS) had its counterpart in

content (CO). Unlike our findings for NS, TM and MV were not significant. However, there were significant differences for TA, % RL, and % RG.

As observed in Table 1, if idea units are a measure of complexity, the "B" passage should have been considered conceptually simpler. In the case of TA, the mean for "B" (.52) is higher than for "A" (.40). Given a simpler passage, achieving concordance should be easier. What is not obvious is that the percentage scores for RL and RG are higher for the more difficult "A" passage (47.1 versus 40.1 and 85.1 versus 76.6) respectively.

To test our assumptions regarding the criticality of number of sentences and content, we reanalyzed the data with TM, MV, and TA as covariates. The MANCOVA findings are given in Table 5. All approximate F values reported are Hotellings.

Insert Table 5 about here

Again, there were no interaction effects. There were main effects, however, for NS and CO. Paralelling our MANOVA analyses, the univariate F values for % RL and % RG within NS and CO are given in Table 6.

Insert Table 6 about here

The means and standard deviations for % RL and % RG within CO and NS are given in Table 7.

Insert Table 7 about here

MANCOVA yielded a pattern of results similar to that for MANOVA. Within number of sentences the 13-sentence passage % RL and % RG mean scores are higher

(47.4 and 83.0 versus 39.3 and 79.2 respectively). Within content, the "A" passage % RL and % RG mean scores are higher than "B" (47.1 and 85.1 versus 39.6 and 77.1 respectively). Findings for higher recognition than recall scores are consistent with the literature.

However, at the moment we can only speculate why the more complex "A" passage produced higher recall and recognition scores. There are no significant interaction effects, and both sets of analyses lead to the inescapable conclusion that passage length and content must be treated as random variables.

Finally, we decided to examine the impact of number of tokens used (TK). Previous studies involving student choice of feedback did not take into account frequency of subject usage. Correlating TK against TM, MV, % RL, %RG, and TA yielded no significant findings. Furthermore, the mean number of tokens used did not reflect passage length. These data are given in Table 8.

Insert Table 8 about here

Subjects dealing with the 19 sentence passages tended to use fewer tokens, although the differences are not statistically significant. The absence of significant differences is not surprising in light of the MANOVA and MANCOVA findings.

If feedback did not yield statistical differences, did it have any impact at all? A secondary analysis involving the protocols (i.e., subject-assigned order of sentences) shows some interesting trends.

Arbitrarily we divided the 13-sentence passages into two units, consisting of sentences 1-6 and 7-13. For the 19-sentence passages, the divisions were sentences 1-6, 7-13, and 14-19. For passage A-13, none of the subjects in the non-feedback condition put the first six sentences in the preassigned order. The maximum occurrence of sentences from the first six in the first six slots,

without respect for order, is 48 (i.e., 8 subjects x 6 sentences). Protocol analyses indicate that 37 of the 48 slots indeed consisted of Sentences 1-6 (77.1%) in any order. This means there were 11 intrusions (i.e., Sentences 7-13). For Sentences 7-13, none were in the preassigned order. Of the 56 slots available, 45 (80.4%) consisted of Sentences 7-13. Again, there were 11 intrusions, consisting of Sentences 1-6 not previously placed correctly.

The A-13 feedback group displayed somewhat different results. Two subjects exactly reproduced the preassigned order for Sentences 1-6. Again, with a potential of 48 card placements, 33 (68.8%) included Sentences 1-6. This is quite startling, given the fact that two subjects exactly reproduced the preassigned order; the other subjects seemed to have been hindered by feedback. That is, two subjects accounted for 12 cards, while the other 6 accounted for 21. Moving on to Sentences 7-13, we find 41 (73.2%) correctly grouped. Again, the 15 intrusions represent the incorrectly placed 1-6 sentences. However, regardless of degree of agreement, there were no differences in % RL and % RG scores attributable to concordance with the preassigned order. Table 9 gives the data for all the passages.

Insert Table 9 about here

While the number of sentences used per unit in the protocol analyses was arbitrary, two trends appeared. The first, regardless of feedback length, concordance generally diminishes with passage length. Subjective organization seems to take over. Second, there are significant content differences. For example, under the no-feedback condition, subjects tested with the B-13 passage correctly grouped sentences within the two units, although no single subject reproduced the preassigned order. One could also speculate that in the feedback conditions, the two subjects who correctly reproduced sentence order for 1-13

used feedback most efficiently. Certainly, the protocol analyses further emphasized the significance of passage content and length, as well as the idiosyncratic nature of processing.

The unique nature of processing can also be demonstrated by correlating TA with % RC and % RG scores. The simple rs of .25 and -.11 are non-significant. A basic assumption of most text processing generally follows some set of universal principles such as serial order. In this study, agreement with serial order of the original did not seem necessary for understanding.

Discussion

Over a decade ago Clark's classic article (1973) warned about the treatment of content as a fixed-effect. Dealing with the issue of semantic memory, he suggested that content also be considered a random variable, along with subjects. Unfortunately, his warnings have been generally ignored, at least in the literature on instructional use of feedback.

Nevertheless, the findings of this text synthesis approach suggest that a major problem in the feedback area has been the issue of content. Almost invariably the experimental procedure has been to construct a highly organized passage, or series of passages, following a predetermined logical algorithm. Generally, material developed by a curriculum writer, whose experiential background is probably significantly different from inexperienced readers, is considered acceptable if it "makes sense" to the author.

Given this sequenced set of materials, the reader has no choice but to determine at the outset the logical structure, and to use feedback to match initial and developing estimates of the author's intent. Essentially, the reader must modify whatever idiosyncratic strategies they have available. The conflict is between subjective organization and predetermined logic, and the criticality to the reader of variances with respect to the original logic.

Since confirmation/disconfirmation is defined with respect to a

predetermined model, one can wonder about the depth of processing. Certainly findings of short-circuiting of the instructional process (e.g., Anderson et al., 1971) may reflect something about depth and commitment to processing. It is no wonder that feedback may hinder as well as have no discernible impact on retention. Feedback will assist to the extent either the predetermined logical model has been correctly determined, or congruence with the learner strategies.

The text synthesis method, we feel, more clearly reveals this problem. In the text synthesis method, the reader is dependent early upon internal knowledge resources, since the initial logic is not immediately apparent. As the reconstruction goes on, the reader can establish through feedback whether the logic used is compatible to that of the author. That is, is the reader's developing comprehension ever brought into question by what follows? In this study concordance was not a factor in recall or recognition scores, which suggests that subjects had organized the passages in idiosyncratic but acceptable ways, i.e., organizations which did not impact subsequent performance. Analyses of the protocols yielded clusterings and "runs" of sentences, and these appeared adequate for the task. These findings directly challenge feedback approaches which assume an "overkill" is necessary or desirable.

Feedback, as we have argued, is usually designed to meet instructional intent with too little consideration of reader need. Obviously, giving the reader control over when feedback is to be utilized provides some flexibility, in that the user is not bombarded with unusable information at inappropriate times. Also, a functional subjective organization can be allowed to develop, i.e., functional in terms of the criterion task.

However, the type of feedback may also have to vary (e.g., Kulhavy, 1984). That is, this study used a simple confirmation/disconfirmation approach; it may be that the reader should have available options regarding the kinds of feedback

needed--a type of menu. The text synthesis approach enables the experimenter to explore both timing and menu much more sensitively than current fixed-logic approaches.

Instead of expending time on a priori passage logic and complex linear model feedback aids, a better approach might be to derive feedback alternatives from the text synthesis approach and let the reader make the appropriate choice. In addition, the subject-controlled menu/timing approach could be explored in terms of such variables as delayed retention, transfer, type of criteria task, cognitive complexity (i.e., content), etc. From these findings, principles may be derived to assist instructional development. The findings of this study appear congruent with current work in cognitive psychology, and considerably at variance with most associative feedback models.

Footnote

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Table 1

Passage Idea Units

Passage	Idea Units
A-13	51
B-13	38
A-19	81
B-19	61

Table 2

MANOVA

Variables	Value	Approximate F	P
FB*	.25	2.63	.03
NS	2.49	25.92	.0001
CO	.42	4.40	.002
FB x NS	.14	1.41	ns
FB x CO	.16	1.63	ns
NS x CO	.16	1.66	ns
FB x NS xCO	.13	1.32	ns

*df = 5,52

Table 3

MANOVA; Univariate Fs for Dependent Variables

Condition	Dependent Variable	F	P
FB	TM*	11.6	.001
	MV	5.7	.020
	TA	.11	ns
	%RL	.79	ns
	%RG	2.37	ns
NS	TM	44.5	.001
	MV	28.6	.001
	TA	33.1	.001
	%RL	4.7	.04
	%RG	3.7	ns
CO	TM	.35	ns
	MV	.07	ns
	TA	.52	.03
	%RL	4.1	.05
	%RG	16.4	.001

*df = 1,56

Table 4

Group Means and (Standard Deviations)

Condition	TM (in min.)	MV	TA	%RL	%RG
Feedback	13.2 (6.7)	12.3 (8.1)	.50 (.29)	44.8 (16.9)	81.2 (9.9)
No feedback	9.0 (5.9)	8.8 (6.3)	.41 (.32)	42.7 (16.4)	80.3 (10.0)
13 sentences	7.3 (3.3)	6.6 (4.1)	.63 (.21)	48.2 (16.2)	83.2 (10.5)
19 sentences	15.2 (6.7)	14.4 (7.9)	.20 (.28)	39.3 (16.0)	79.2 (9.2)
Selection A	11.5 (7.3)	10.7 (7.0)	.40 (.28)	47.1 (17.7)	85.1 (7.2)
Selection B	11.0 (5.8)	10.3 (7.9)	.52 (.31)	40.1 (15.3)	76.6 (10.6)

Table 5

MANCOVA; Time, Moves, and Tau as Covariates

Variable	Value	Approximate F	P
FB*	.005	.13	ns
NS	.34	8.71	.001
CO	.29	7.54	.001
FB x NS	.07	2.25	ns
FB x CO	.02	.58	ns
NS x CO	.02	.51	ns
FB x NS x CO	.07	1.69	ns

*df = 2,52

Table 6

MANCOVA: Univariate Fs for % Recall and % Recognition

Condition	Variable	F	P
CO	%RL*	4.38	.04
	%RG	11.18	.002
NS	%RL	5.28	.03
	%RG	12.71	.001

*df = 1,53

Table 7

Recall and Recognition Means and (Standard Deviation)

For Passage

Variable	Condition		
	CO		
	A		B
%RL	47.1 (16.1)		39.6 (13.6)
%RG	85.1 (7.2)		77.1 (9.2)
	13	NS	19
%RL	47.4 (15.3)		39.3 (16.0)
%RG	83.0 (8.8)		79.2 (9.2)

Table 8

Mean Number of Tokens Used

		Number of Sentences	
		13	19
Content	A	3.6	3.3
Content	B	2.9	2.9

Table 9

Agreement with Preassigned Order

Passage	Sentences 1-6	Sentences 7-13	Sentences 14-19	# of Ss giving preassigned order
A-13 FB	33/48 (68.8%)	41/56 (73.2%)	----------	2
A-13 No FB	37/48 (77.1%)	45/56 (80.4%)	----------	0
B-13 FB	48/48 (100%)	56/56 (100%)	----------	0
B-13 No FB	48/48 (100%)	56/56 (100%)	----------	0
A-19 FB	17/48 (35.4%)	21/56 (35.6%)	23/48 (47.9%)	0
A-19 No FB	16/48 (33.3%)	28/56 (50.0%)	17/48 (35.4%)	0
B-19 FB	37/48 (77.1%)	31/56 (55.4%)	24/48 (50.0%)	0
B-19 No FB	27/48 (56.3%)	17/56 (30.4%)	11/48 (22.9%)	0

Appendix A

Version A-13

1. A shipment of crates arrived at the Chicago stadium on a Saturday.
2. The hired men who would normally unpack them were not working.
3. A university professor, older by several years than Herbert, gave a look at the crates.
4. "Those fellows will unpack them Monday morning," he said lightly.
5. "Those fellows, Hell! We'll do them now," flared Herbert.
6. Herbert never felt inhibited in the presence of men older or higher in the academic hierarchy.
7. Profanity was used freely at the Met Lab.
8. The professor took off his coat, and the two of them started wrenching at the crates.
9. Would Germany get atomic weapons before the United States developed them?
10. Would these weapons come in time to help win the war?
11. These unanswered questions were constantly in the minds of the project leaders.
12. Their presence pressed the group to work faster and faster, to be tense, and to swear.
13. It relieved the tension built up by having to work against time.

Appendix B

Version A-19

1. Herbert Anderson and his group at the lab had also been building small piles.
2. The best place they had been able to find for work on the pile was a squash court under the football field.
3. The physicists would have liked more space, but the expanding armed forces had requisitioned all the space.
4. They were still very "small piles" because materials came in at a very slow if steady pace.
5. As each new shipment of crates arrived, Herbert's spirits rose.
6. He could work all hours and drive his associates to work along with his same intensity and enthusiasm.
7. A shipment of crates arrived at the Chicago Stadium on a Saturday.
8. The hired men who would normally unpack them were not working.
9. A university professor, older by several years than Herbert, gave a look at the crates.
10. "Those fellows will unpack them Monday morning," he said lightly.
11. "Those fellows, Hell!" We'll do them now," flared Herbert.
12. Herbert never felt inhibited in the presence of men older or higher in the academic hierarchy.
13. Profanity was freely used at the Met Lab.
14. The professor took off his coat, and the two of them started wrenching at the crates.
15. Would Germany get atomic weapons before the United States developed them?
16. Would these weapons come in time to help win the war?
17. These unanswered questions were constantly in the minds of the project leaders.

18. Their presence pressed the group to work faster and faster, to be tense, and to swear.

19. It relieved the tension built up by having to work against time.

Appendix C

Version B-13

1. Herbert Anderson went to the Goodyear Tire and Rubber Company to place an order for a square balloon.
2. The Goodyear people had never heard of square balloons, they did not think they could fly.
3. At first they threw suspicious glances at Herbert.
4. The young man, however, seemed to be in full possession of his wits.
5. He talked earnestly and knew exactly what he wanted.
6. The Goodyear people promised to make a square balloon of rubberized cloth.
7. It came neatly folded, but once unfolded, it was a huge thing that reached from floor to ceiling.
8. The room ceiling could not be pushed up as the physicists would have liked.
9. They had calculated that their final pile ought to chain-react somewhat before it reached the ceiling.
10. But not much margin was left and calculations are never to be trusted entirely.
11. In addition, some unforeseen factor might upset theory.
12. The critical size of the pile might not be reached at the ceiling.
13. Since the room imposed a concrete limit, they thought of improving the performance of the pile other than by size.

Appendix D

Version B-19

1. Herbert Anderson went to the Goodyear Tire and Rubber Company to place an order for a square ballocn.
2. The Goodyear people had never heard of square balloons, they did not think they could fly.
3. At first they threw suspicious glances at Herbert.
4. The young man, however, seemed to be in full possession of his wits.
5. He talked earnestly and knew exactly what he wanted.
6. The Goodyear people promised to make a square balloon of rubberized cloth.
7. They delivered it a couple of months later.
8. It came neatly folded, but once unfolded, it was a huge thing that reached from floor to ceiling.
9. The room ceiling could not be pushed up as the physicists would have liked.
10. They had calculated that their final pile ought to chain-react somewhat before it reached the ceiling.
11. But not much margin was left and calculations are never to be trusted entirely.
12. Some impurities in the pile materials might go unnoticed.
13. In addition, some unforeseen factor might upset theory.
14. The critical size of the pile might not be reached at the ceiling.
15. Since the room imposed a concrete limit, they thought of improving the performance of the pile other than by size.
16. There had been an experiment at Columbia with a canned pile.
17. The Columbia experiment suggested that performance could be improved by removing air from the graphite pores.
18. To can as large a pile as they were to build was now impractical.
19. They could, however, assemble their pile inside a square balloon and pump the air out.

Appendix E

Recognition Test: A-13

1. *Would they be ready soon enough to serve as weapons in winning the war?
   Would these weapons come in time to help win the war?
2. A university professor, older by several years than Herbert, gave a look at the crates.
   *A university professor who was several years older than Herbert looked at the crates.
3. A shipment of crates arrived at the Chicago stadium on a Saturday.
   *It was a Saturday in Chicago when the shipment of crates arrived.
4. Profanity was freely used at the Met Lab.
   *The men at the Met Lab used profanity freely.
5. These unanswered questions were constantly in the minds of the project leaders.
   *Leaders of the project had these unanswered questions constantly in their minds.
6. Herbert never felt inhibited in the presence of men older or higher in the academic hierarchy.
   *Men older than Herbert or higher in the academic hierarchy never inhibited him.
7. *They would normally be unpacked by hired men who were not working.
   The hired men who would normally unpack them were not working.
8. *In their presence, the group was pressed to work faster and faster, to be tense, and to swear.
   Their presence pressed the group to work faster and faster, to be tense, and to swear.
9. "Those fellows will unpack them Monday morning," he said lightly.
   *"Monday morning," he said lightly, "those fellows will be here to unpack

them."

10. The professor took off his coat, and the two of them started wrenching at the crates.

*As the professor took his coat off, the two of them started wrenching at the crates.

11. "Those fellows, Hell!" flared Herbert, "We will unpack them now."

*"Those fellows, Hell! We'll do them now," flared Herbert.

12. It relieved the tension built up by having to work against time.

*It gave relief from the tension of having to work against time.

13. *Would atomic weapons be developed in Germany before the United States had them?

Would Germany get atomic weapons before the United States developed them?

*Paraphrased Version

Appendix F

Recognition Test: A-19

1. *"Those fellows, Hell!" flared Herbert, "We will unpack them now."
   "Those fellows, Hell! We'll do them now," flared Herbert.
2. *It gave relief from the tension of having to work against time.
   It relieved the tension built up by having to work against time.
3. *Since materials came in at a very slow though steady pace, they were still very "small piles."
   They were still very "small piles" because materials came in at a very slow if steady pace.
4. Would Germany get atomic weapons before the United States developed them?
   *Would atomic weapons be developed in Germany before the United States had them?
5. He could work all hours and drive his associates to work along with his same intensity and enthusiasm.
   *He worked all hours and drove his associates to work along with his same enthusiasm and intensity.
6. "Those fellows will unpack them Monday morning," he said lightly.
   *"Monday morning," he said lightly, "those fellows will be here to unpack them."
7. *Would they be ready soon enough to serve as weapons in winning the war?
   Would these weapons come in time to help win the war?
8. *Men older than Herbert or higher in the academic hierarchy never inhibited him.
   Herbert never felt inhibited in the presence of men older or higher in the academic hierarchy.
9. A shipment of crates arrived at the Chicago stadium on a Saturday.
   *It was Saturday in Chicago when the shipment of crates arrived.

10. *A university professor who was several years older than Herbert looked at the crates.

    A university professor, older by several years than Herbert, gave a look at the crates.

11. Profanity was freely used at the Met Lab.

    *The men at the Met Lab used profanity freely.

12. *Leaders of the project has these unanswered questions constantly in their minds.

    These unanswered questions were constantly in the minds of the project leaders.

13. The best place they had been able to find for work on the pile was a squash court under the football field.

    *A squash court under the football field was the best place they could find for work on the pile.

14. The hired men who would normally unpack them were not working.

    *They would normally be unpacked by hired men who were not working.

15. *Although the physicists would have liked more space, it had all been requisitioned by the expanding armed forces.

    The physicists would have liked more space, but the expanding armed forces had requisitioned all the space.

16. *As the professor took his coat off, the two of them started wrenching at the crates.

    The professor took off his coat, and the two of them started wrenching at the crates.

17. As each new shipment of crates arrived, Herbert's spirits rose.

    *Herbert's spirits rose with the arrival of each new shipment of crates.

18. Their presence pressed the group to work faster and faster, to be tense, and to swear.

    *In their presence the group was pressed to work faster and faster, to be tense, and to swear.

19. *Herbert Anderson had also been building small piles with his group at the lab.

    Herbert Anderson and his group at the lab had also been building small piles.

*Paraphrased Version

Appendix G

Recognition Test: B-13

1. The people at Goodyear promised to make his square balloon using rubberized cloth.

   *The Goodyear people promised to make a square balloon of rubberized cloth.

2. But not much margin was left and calculations are never to be trusted entirely.

   *Not much margin was left, however, and calculations are never entirely to be trusted.

3. Herbert Anderson went to the Goodyear Tire and Rubber Company to place an order for a square balloon.

   *A square balloon was ordered by Herbert Anderson at the Goodyear Tire and Rubber Company.

4. *The pile might not reach critical size at the ceiling.

   The critical size of the pile might not be reached at the ceiling.

5. The young man, however, seemed to be in full possession of his wits.

   *However, the young man seemed fully in possession of his wits.

6. Since the room imposed a concrete limit, they thought of improving the performance of the pile other than by size.

   *They thought of ways of improving performance of the pile other than by size, because the room imposed a concrete limit.

7. In addition, some unforeseen factor might upset theory.

   *Further, theory might be upset by some unforeseen factor.

8. *He spoke earnestly, knowing exactly what he wanted.

   He talked earnestly and knew exactly what he wanted.

9. *By their calculations, the final pile should chain-react a bit before reaching the ceiling.

   They had calculated that their final pile ought to chain-react somewhat before it reached the ceiling.

10. At first they threw suspicious glances at Herbert.

    *They gave Herbert suspicious glances at first.

11. The room ceiling could not be pushed up as the physicists would have liked.

    *The ceiling of the room could not be raised as these physicists would have wished.

12. *It came folded neatly, but it was a huge thing and once unfolded it reached from floor to ceiling.

    It came neatly folded, but once unfolded, it was a huge thing that reached from floor to ceiling.

13. *They had never heard of square balloons at Goodyear and they did not think they could fly.

    The Goodyear people had never heard of square balloons, they did not think they could fly.

*Paraphrased Version

Appendix H

Recognition Test: B-19

1. He talked earnestly and knew exactly what he wanted.

   *He spoke earnestly, knowing exactly what he wanted.

2. *From the Columbia experiment it appeared that performance might be improved by removing air from the pores in the graphite.

   The Columbia experiment suggested that performance could be improved by removing air from the graphite pores.

3. *It came folded neatly, but it was a huge thing and once unfolded it reached from floor to ceiling.

   It came neatly folded, but once unfolded, it was a huge thing that reached from floor to ceiling.

4. *The ceiling of the room could not be raised as these physicists would have wished.

   The room ceiling could not be pushed up as the physicists would have liked.

5. *Materials in the pile might have unnoticed impurities.

   Some impurities in the pile materials might go unnoticed.

6. At first they threw suspicious glances at Herbert.

   *They gave Herbert suspicious glances at first.

7. *The Goodyear people promised to make a square balloon of rubberized cloth.

   The people at Goodyear promised to make his square balloon using rubberized cloth.

8. *However, the young man seemed fully in possession of his wits.

   The young man, however, seemed to be in full possession of his wits.

9. *By their calculations, the final pile should chain-react a bit before reaching the ceiling.

   They had calculated that their final pile ought to chain-react somewhat before it reached the ceiling.

10. Herbert Anderson went to the Goodyear Tire and Rubber Company to place an order for a square balloon.

    *A square balloon was ordered by Herbert Anderson at the goodyear Tire and Rubber Company.

11. *Further, theory might be upset by some unforeseen factor.

    In addition, some unforeseen factor might upset theory.

12. They delivered it a couple of months later.

    *It was delivered a couple of months later.

13. To can as large a pile as they were to build was now impractical.

    *It was now impractical to can a pile as large as they were building.

14. *At Columbia there had been an experiment with a canned pile.

    There had been an experiment at Columbia with a canned pile.

15. *They had never heard of square balloons at Goodyear and they did not think they could fly.

    The Goodyear people had never heard of square balloons, they did not think they could fly.

16. The critical size of the pile might not be reached at the ceiling.

    *The pile might not reach critical size at the ceiling.

17. *Not much margin was left, however, and calculations are never entirely to be trusted.

    But not much margin was left and calculations are never to be trusted entirely.

18. *The pile could be assembled inside the square balloon, however, and the air could be pumped out.

    The could, however, assemble their pile inside a square balloon and pump the air out.

19. Since the room imposed a concrete limit, they thought of improving the performance of the pile other than by size.

    *They thought of ways of improving performance of the pile other than by size, because the room imposed a concrete limit.

*Paraphrased Version